Buyer's Guide to Forage Products

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Buyer's Guide to Forage Products

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SITUATION

Hay sellers and purchasers, in conjunction with the National Hay Marketing Association, National Alfalfa Hay Quality Committee, American Forage & Grassland Councils and others have been involved in establishing hay quality standards across the country. Buyers in Alaska and elsewhere often find that both excellent and poor quality forage are available at the same selling price. The ability to select and purchase a higher quality forage will save the buyer money and promote quality forage producers.

Variations in quality are common among feeds, however, forages vary much more widely than grains and most other feedstuffs (Templeton, 1984). Examples of the variability in chemical analyses of some Alaska produced forages are shown in Table 1. Some nutritive values varied as much as 2-to-13 times or more.

Table 1. Ranges and Averages of Chemical Analyses for Various Alaska Forages

Feed		Number of samples	CP (%)	ADF (%)	TDN (%)	ME (Mcal/lb)
Grass Silage	Maximum	20	19.80	48.18	68.00	1.18
	Minimum		5.66	26.97	44.00	0.66
	Average		12.13	37.19	55.70	0.91
Small Grain Silage	Maximum	5	17.41	40.84	60.00	0.97
	Minimum		6.83	26.89	50.00	0.82
	Average		13.92	34.61	55.80	0.89
Timothy Hay	Maximum	111	17.34	47.08	69.00	1.18
	Minimum		3.04	26.70	44.00	0.68
	Average		9.41	38.23	53.63	0.88
Oat Hay	Maximum	7	11.49	44.26	64.00	0.98
	Minimum		6.62	34.06	47.00	0.75
	Average		9.63	38.05	54.42	0.88
Brome	Maximum	142	22.77	49.83	76.00	1.34
	Minimum		3.51	16.46	40.00	0.61
	Average		11.01	35.62	56.68	0.94
Alfalfa*	Maximum					
	Minimum					
	Average					

Source: Jahns & Chumley 2001

CP = Crude Protein
ADF = Acid Detergent Fiber
TDN = Total Digestible Nutrients
ME = Metabolizable Energy
*Primarily imported into Alaska Source: Quarberg & Comeau, 1992.

Forage quality is defined as "the ability of a forage to supply animal nutrient requirements for a specific production function such as meat, milk, wool or work." (Vough, 1978). Forage quality is essentially the same as forage feeding value considering nutrient and chemical constituents, intake potential, digestibility and efficiency that absorbed materials are converted into livestock production (Linn and Martin, 1986). High quality hay to a horse owner is not necessarily the same as high quality forage to a goat owner. The laws of supply and demand ultimately establish the monetary value of any forage. When an oversupply of forage exists, selling prices are depressed. A shortage causes the opposite effect. In Alaska, the selling price for local hay is often determined by the cost of importing comparable quality hay from Canada or the lower United States.

Production management has a pronounced effect on the final quality of a forage. Fertilization practices used in producing the forage greatly impact yield and quality (Table 2). Yields and crude protein production were increased by 296% and 536%, respectively with fertilization. Plant maturity at harvest is one of the most easily controlled factors that drastically effects forage quality. As seen in Table 3, delaying the harvest results in much lower quality forage. Proper forage storage is necessary to retain the quality at the time of harvest. The potential loss in forage quality that can occur when hay is stored outside is shown in Table 4. A variety of storage methods is used by both producers and hay purchasers to greatly reduce these losses (Table 5).

Table 2. Response of Bromegrass to Different Nitrogen Treatments With 80 lb P_2O_5 and 40 lb K_2O per Acre

Pounds of nitrogen per acre per year	Crude Protein in crop (%)	Crude Protein in crop (lb/a)	Dry Matter (lb/a)	Approximate yields Hay (ton/a)	Approximate yields Silage (ton/a)
None	11.2	100	878	0.5	1.5
16	11.4	132	1,158	0.7	2.2
32	12.4	182	1,467	1.0	3.0
64	14.6	324	2,213	1.7	4.5
128	18.3	636	3,480	2.3	7.0

Reference: Sweetman & Brundage, 1960

Table 3. Quality and Quantity of Bromegrass Harvested at Different Stages of Maturity

Date	Stage of growth when harvested	Crude Protein (%)	Yields Hay (lb/a)	Yields Protein (lb/a)
5/28	3-to-6 inches of early growth	27.4	1080	237
6/12	Internodes elongating, 10" high	22.1	1835	324
6/26	Still growing, 27" high	13.7	3600	394
7/10	Panicles emerged, full bloom	12.2	4364	426
8/07	Seeds developing	10.2	5079	414
8/28	Seed ripened, leaves yellow	5.4	6030	259
9/25	Leaves dry and shattering	4.2	3392	113

Reference: Sweetman & Brundage, 1960

Table 4. Annual Losses for Round Bales of Forage Stored Outside

Type of loss	Extent of loss
Shrinkage in size	50%
Weight loss	30%
Increased moisture content	20%
Total dry matter loss	65%
Reduction in digestibility	25%

Source: Thomas, 1986.

Table 5. Methods of Hay Storage and Estimated Annual Reduction in Nutrient Losses

Storage method	Estimated annual reduction in storage losses
Uncovered, outside, on ground	0%
Uncovered, outside, on gravel* or tires	20%
Uncovered, outside, on pallets	35%
Covered, outside, on ground	50%
Covered, outside, on gravel* or tires	70%
Covered, outside, on pallets	85%
Inside on a dirt floor	90%
Inside on a raised floor	95%

Source: Thomas, 1986.

* Warning: Gravel can become embedded in the bottom bales and adversely affect health if fed to livestock

The specific nutritional requirements of livestock determine the quality of forage necessary for their care (Table 6). Knowing the forage quality an animal needs is essential and offers the buyer some options in selecting a feed. The National Research Council has established nutrient requirements for most domestic livestock.

Table 6. Nutrient Requirements of Animals

	CP (%)	TDN (%)	ME (Mcal/lb)
Horse - 1100 lb mare			
Maintenance/Pregnant	8.0	50.0	0.82
Pregnant (last 3 months)	10.2	56.7	0.93
Lactating (early)	13.5	63.7	1.04
Offspring			
Nursing foal	18.4	70.4	1.16
Weanling	15.8	70.9	1.17
Yearling	12.7	63.7	1.04
2-year-old	9.6	56.8	0.93
Goat - 100 lb doe			
Dry/Pregnant	10.6	56.0	0.91
Pregnant (last 8 weeks)	11.1	60.0	0.99
Lactating (early)	12.2	64.0	1.06
Offspring			
Kids	13.9	74.0	1.22
Yearlings	11.5	66.0	1.08
Beef - 1100 lb cow			
Dry/Pregnant	7.0	48.8	0.80
Pregnant (last 3 months)	7.9	53.6	0.88
Lactating (early)	9.6	56.6	0.93
Offspring			
550 lb weaners (2.4 lb/day gain)	12.1	77.0	1.27
880 lb yearlings (2.9 lb/day gain)	10.4	86.0	1.41
Alaska Feed Comparisons			
Average Delta Brome Hay	11.9	57.0	0.95
Average Delta Barley	11.9	80.1	1.29

CP = Crude Protein
TDN = Total Digestible Nutrients
ME = Metabolizable Energy

Source: Ensminger and Olentine, 1978

METHODS OF EVALUATING FORAGES

Physical inspection has been the most common forage evaluation method in the United States (Wickwire, et al., 1991; Vough, 1978; Dairy Management Manual Committee, 1989), including Alaska. The following parameters are commonly used:

1. **Forage Weight**. If at all possible weigh the entire lot, otherwise weigh several bales to obtain an average weight for the forage purchased. This is the most equitable method for the buyer, seller, and transporter.

2. **Color** of the forage is important, but it is not a good indicator of digestibility. Bright green color generally indicates that the forage was cut prior to maturity and cured properly. Green color is usually associated with good quality, while yellow, brown and black colors suggest progressively lower quality forages.

3. **Maturity**. Plant maturity at harvest can be used to evaluate potential forage quality. Nutritional content and digestibility of forages decline as they mature. Look for evidence of seeds, seedheads and coarse woody stems, all of which indicate overmaturity. Grasses requiring exposure to winter conditions for production of seedheads (bromegrass, bluegrass, redtop, fescue) will not produce seedheads from basal tillers following the first cutting. Consequently, the second crop of bromegrass will contain few, if any, seedheads. Timothy will produce seedheads during the second crop growth (Smith, et al., 1986). Advanced maturity indicates lower potential quality.

4. **Varieties**. Quality variations between different varieties of forage are not usually as great as those among a single variety caused by management factors (see Table 1). Table 7 shows the average chemical analyses of several forage varieties as determined by the National Research Council. Management practices cause greater variations in forage quality than does forage variety.

Table 7. Comparison of Average Chemical Nutrient Content Among Forage Varieties

Variety	CP (%)	CF (%)	ADF (%)	TDN (%)	ME (Mcal/lb)
Alfalfa	17.6	30.1	36.1	56	1.07
Bluegrass	8.9	31.5		56	0.91
Bluejoint	9.7	34.0		58	0.95
Smooth Bromegrass	13.2	33.3	34.9	58	1.03
Meadow Fescue	9.1	33.4		58	0.94
Oat Hay	8.9	32.4	38.5	57	1.02
Timothy	8.4	33.3	37.3	57	0.92

CP = Crude Protein
CF = Crude Fiber
ADF = Acid Detergent Fiber
TDN = Total Digestible Nutrients
ME = Metabolizable Energy

Source: Ensminger and Olentine, 1978

5. **Impurities**. Inspect forages for impurities or foreign materials. There are basically two types.
   a. Harmless impurities, which seldom injure an animal, include:
      1. Crop residue, sticks, dirt and rocks, all of which lower quality and palatability.

      2. Weeds, which affect palatability, but also serve as a source for contaminating the farm/feedlot either directly from the hay or indirectly through animal wastes. **Caution**: Some weeds are regulated by the Alaska Administrative Code:

         11 AAC 34.077 Natural Resources
         WEED SEEDS IN SHIPMENT. Whenever anything brought into a part of the state from another part of the state or from any other state or foreign country is found to be infested with the seed of any prohibited noxious weed, the director will notify the owner or bailee of the shipment to return it to the point of shipment within 48 hours, and the owner or bailee of the shipment shall return it. If the director determines that the seeds can be destroyed by treatment, the shipment may, at the option and expense of the owner or bailee, be treated under the supervision of the director, and may be released after treatment (Eff. 10/28/83, Register 88).

   b. Harmful objects can physically injure an animal. Examples include nails, wire and awned weeds (foxtail-barley), which can puncture the mouth, tongue, esophagus and/or stomach.

6. **Molds** may produce toxins or poisons and odors. Look for presence of molds and check or smell for musty or mildewy odors that indicate the presence of spores. These contaminants usually result from hay being improperly cured. Hays testing 15 to 20% moisture in the winter may be contaminated with some mold because they may have been baled at moisture contents exceeding 20%.

7. **Forage Packaging** influences difficulty in handling, storage, feeding losses and potential for spoilage.
   a. **Large bales** (750 - 1000 lb or more) require mechanized handling and are susceptible to spoilage if baled at 17 to 18% moisture or higher. Feeding losses (waste) can be high if not placed in a feeder of proper design.

   b. **Small bales** (35 - 70 lb) require more labor to produce and handle on a ton basis and may mold if baled at 20% moisture or higher. Loose bales suggest that the moisture content was high at harvest.

   c. **Pellets or cubes** require more labor and cost to manufacture, while also being more difficult to judge for other physical factors.

   d. **Silages or haylages** have higher moisture contents and shorter feed bunk lives before spoilage begins. They usually require special feeding and handling equipment. Handling costs are higher per unit of dry forage, because of the increased water content.

Chemical analyses measure the nutrient content in forages (Krieg, 1991). The standard feed analysis available through the Cooperative Extension Service includes the following:

1. **Dry Matter Content (DMC)** tells how much dry hay is in the sample. Subtracting this value from 100 will indicate the percent of water in the hay.

2. **Crude Protein (CP)** is the total protein (available plus unavailable) in the forage as determined by the total nitrogen content.

3. **Acid Detergent Fiber (ADF)** measures the highly indigestible and slowly digestible material in the forage. Higher ADF values correlate to lower forage digestibility.

4. **In Vitro Dry Matter Disappearance (IVDMD)** is an estimate of feed digestibility and is used to calculate metabolizable energy. It can be thought of as a measure of energy release.

5. **Total Digestible Nutrients (TDN)** is the sum of the energy values for the digestible protein, fats and carbohydrates in the forage.

6. **Metabolizable Energy (ME)** is a measure of the amount of gross feed energy remaining after deducting for losses in animal wastes and gases.

Optional chemical analyses available include:

1. **Neutral Detergent Fiber (NDF)** is used to estimate the amount of a forage an animal will potentially eat. Generally, the lower the NDF value, the more forage an animal will eat. (Undersander, et al., 1990). This test is popular in evaluating dairy forages where maximum consumption is desired. NDF is an important analysis used in determining relative feed value of various forages, especially in the dairy industry.

2. **Acid Detergent Insoluble Nitrogen (ADIN)** is a measure of unavailable or bound nitrogen in the acid detergent fiber portion of a forage. Mathematically, ADIN can be converted to insoluble protein when adjusting rations for digestibility. The digestibility of protein in fresh forage can reach 70%, but if heating occurs, it can drop to 20% (McQueen, 1982). ADIN tests should be conducted whenever heating of the forage is suspected. As a rule of thumb, when acid detergent insoluble protein exceeds 12% of the crude protein in the forage, some heat damage has occurred (Barnhart, 1990). If the bound protein value exceeds 15%, extensive heating has occurred (Holland and Kezar, 1990). Table 8 shows that crude protein is not a reliable indicator of forage quality when heat damage has occurred. The local Cooperative Extension Service office can help determine digestible crude protein from ADIN values.

Table 8. How Heat Damage Affects Forage Quality

Insoluble Protein* (%)		Digestible Energy Loss (%)	Crude Protein (%)	Available Crude Protein (%)
5	Normal	0	20	20.0
10	Values	10	20	18.2
15	Increasing	20	20	16.2
20	Heat	30	20	14.4
25	Damage	40	20	12.6

Source: Olson & Goering, 1987.

*Insoluble protein as a percent of total protein

Many other feed testing labs are available in addition to the UAF-AFES lab in Palmer. The Cooperative Extension Service can help locate other labs when requested.

RELIABILITY OF EVALUATION TECHNIQUES

There is no single test that is totally reliable in determining forage quality. Visual analyses cannot accurately or consistently measure the feeding value of a forage. Complete dependence on the chemical analyses can also be misleading (refer to Table 9).

Table 9. Reliability of Hay Quality Evaluation Techniques

Quality factor	Reliability by Visual inspection	Chemical analyses
Green color	Excellent	Poor
Maturity	Good - poor (2nd cut)	Good
Variety	Good	Poor
Impurities	Excellent	Poor
Mold	Excellent	Poor
Nutrient content	Poor	Excellent
Moisture content	Fair	Excellent
Heat damage	Good - poor	Excellent

Source: Dairy Management Manual

BUYER OPTIONS IN COMPARING FORAGE VALUES

Purchasers may refer to publication LPM-00345, *Summary of Alaska Feed Analysis for 1990-2000* as an aid in comparing the chemical analysis data for a particular forage. This reference documents average and extreme values for most commonly analyzed feed ingredients by:

1. Production region within Alaska
2. Average for the entire state
3. Variety

Comparing these nutrient values will help the purchaser evaluate the forage against other products and areas of production.

Physical inspection should be used in conjunction with chemical analyses to determine forage quality and suitability.

FORM OF PACKAGING

Small bales mean higher production costs, are less likely to mold, and easier for small feeders to handle.
Large bales require more difficult handling, and are more susceptible to mold.
Pellets or cubes are more costly to produce, more difficult to evaluate physically, and may be more convenient to some feeders.
Silage has more moisture to handle, and shorter bunk life.

Previously developed grading systems based on specific physical and chemical properties of forages have been adapted for use in Alaska (Table 10).

Table 10. Proposed Hay Grades and Typical Test Values of Grass Hay Harvested at Various Stages of Maturity

Grade, stage of maturity & definition	Physical description	CP (%)	ADF (%)	TDN (%)	ME (Mcal/lb)	Value* (%)
1. PREMIUM; pre-head; late vegetative to early boot	Green; less than 5% impurities; free of mold musty odor, dust	>16	<36	≥56	≥0.94	108%
2. GOOD; early head; boot to early head	Light green to green; less than 10% impurities; free of mold, musty odor, dust	13-15	36-37	54-55	0.90-0.93	105%
3. AVERAGE; head; head to milk, seeds are well formed but soft immature	Yellow green to green; less than 15% impurities; free of mold, musty odor, dust	10-12	38-39	52-53	0.85-0.89	100%
4. FAIR; post-head; dough to seed	Brown to green; less than 20% impurities; slightly musty odor, dust	8-9	40-45	49-51	0.80-0.84	94%
5. POOR; sample grade	Contains more than a trace of harmful impurities or definitely has objectionable odor or is under cured, heat damaged, hot, wet, musty, moldy, caked, badly broken, badly weathered or stained, extremely overripe, dusty, which is distinctly low quality, or contains more than 20% foreign material or more than 20% moisture	<8	>45	<49	<0.80	92%

Adapted from Wickwire, et al., 1991 and Rohweder, et al., 1978

* As a percent of average quality hay (grade #3) based on TDN.

METHODS OF EVALUATING FORAGE VALUES BASED ON QUALITY COMPARISONS

High quality forage costs more to produce because the hay is harvested at a younger stage of growth with lower total yields. However, higher quality forage is worth more to producers opting for high production of milk & meat (Dairy Management Manual Committee, 1989).

1. **Weight**. Weigh the hay if at all possible. Bales of hay can vary in weight by 30% or more. Most hay sales are made on a $/ton basis or at least referenced to a ton price. The only fair way to determine the amount of hay purchased is to weigh it.

2. **Moisture content**. Drier forages not only are less likely to spoil, but are also more concentrated in nutrient content than forages containing higher water amounts. Adjust the value of a forage based on moisture content by using the formula:

$$\text{Adjusted price in \$/ton} = \text{Price of standard forage in \$/ton} \times \frac{\text{\% Dry Matter of forage being considered}}{\text{\% Dry Matter of standard forage}}$$

   Example: Standard forage = 85% Dry Matter at $160/ton
   Considered forage = 87% Dry Matter
   Adjusted $/ton = ($160 X 87/85) or $163.76/ton

3. **Crude Protein content**. Forage values can be adjusted for variations in crude protein content on a dry matter basis by comparing the cost of replacement protein in a concentrate such as soybean meal. Adjust price based on replacement protein by using the formula:

   Value adjustment in $/ton = [(A - B) X C]
   A = (% Crude Protein X % Dry Matter X 2000) for forage being considered
   B = (% Crude Protein X % Dry Matter X 2000) for standard forage
   C = Current value of replacement Crude Protein in $/lb

   Example: What's the value of 13% crude protein hay at 84% dry matter compared to 11% crude protein hay at 85% dry matter if soybean meal costs $0.64/lb of crude protein?

   Adjusted $/ton = [(.13 X .84 X 2000) - (.11 X .85 X 2000)] X $0.64
   = (218.4 - 187) X $0.64
   = 31.4 X $0.64 = $20.10
   The value of the hay is $160 + $20.10 or $180.10/ton

4. **Total Digestible Nutrients**. Forage values may also be adjusted for their TDN content. Since most chemical analysis concentrations are compared on a total dry matter basis so will the TDN levels. Use the formula:

   Adjusted price in $/ton = (A ÷ B) X Price of standard forage in $/ton

   A = % Dry Matter X TDN of considered forage

   B = % Dry Matter X TDN of standard forage

   Example: Compare a forage with 84% dry matter and 50% TDN to the standard forage of 85% dry matter with 53% TDN currently selling at $160/ton.

   Adjusted Price ($/ton) = [(.84 X 50) ÷ (.85 X 53)] X $160.00
   = (42.0 ÷ 45.05) X $160.00
   = .932 X $160.00
   = $149.17

Consequently, the forage under consideration is worth $149.17/ton when comparing TDN values.

Summary

1. **Prepurchase considerations**
   Before purchasing hay or forage a prospective buyer should:

   a. Determine the nutrient quality of forage necessary for their specific livestock.

   b. Conduct a physical inspection of the forage product. Look carefully at color, maturity, mold, impurities and finally, smell the forage to identify any off odors.

   c. Weigh the forage.

   d. Take a sample of the forage and have it chemically analyzed by a competent laboratory. Your local Extension office can provide information and tools for sampling forages, handling the samples and where to send them for analyses. Your Extension agent can also assist in interpreting the results of the analyses.

   e. Negotiate. Depending on the current supply and demand for forage, the seller may be willing to adjust the price based on the nutrient analyses.

   f. Investigate guarantees. Some producers will guarantee that the forage is free of mold. Should a contaminated bale be found, they will exchange it. Check with the seller.

2. **Forage producer considerations**
   Improve your forage markets by:

   a. Improving the quality of forage by changing production management practices such as fertilization programs, time of harvest and/or storage techniques.

   b. Continuing to physically inspect forages as would a prospective buyer.

   c. Conducting chemical analyses to be used in evaluating the effectiveness of quality control methods.

   d. Offering flexibility in pricing forages based on physical and chemical analyses.

   e. Offering to replace forage of unusually low quality.

   f. Determining a fair price for forage based on input costs, fixed costs, risk and management. Being satisfied with a fair price that brings repeat customers.

HAY BUYERS CHECKLIST

Size & shape of bale: small _____ large _____ ; rectangular _____ round _____
(select 1) (select 1)

Bale weight (lb): _____

Storage type: open stack_____ covered stack _____ pole shed _____ enclosed shed_____
(select 1)

Cutting number: first _____ second_____ ; approximate date cut _____
(select 1)

Maturity stage: boot _____ early heading _____ fully headed _____ mature _____
(select 1)

Color: bright green_____ light green _____ yellow _____ brown_____ black _____
(select 1)

Stem texture: fine_____ avg._____ coarse _____ ;soft _____ avg. _____ brittle_____
(select 1) (select 1)

Leaf/stem ratio: leafy _____ Avg. _____ stemmy_____
(select 1)

Impurities: crop residue _____ sticks_____ rocks _____ dirt_____

weeds _____ wire hardware _____ awned weeds_____
(select all that apply)

Odor: good _____ fair _____ poor_____
(select 1)

Damage: moldy _____ musty _____ dusty _____ rained on _____
(select all that apply)

Lab analyses data: Moisture content _____
% CP _____
% TDN _____
% ADF _____
Date of analysis _____

Adapted from - National Hay Exchange

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